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Enhancing Educational Efficiency in the Public Sector: A Data Envelopment Analysis of Schools in District Sargodha

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The quality of education has always been a major concern for both developing and developed countries. Several policies were designed at provincial and national level to deliver quality education at primary and secondary levels in line with objective four of Sustainable Development Goals: Quality Education. It includes equal access to education, upgradation of the existing buildings, provision of basic facilities at schools, access to digitalized education system, provision of distance learning for remote areas and enhancing the skills of teachers to use equipment, instructional aids and technology. The policies have not produced desired outcomes due to several challenges and issues faced by the education sector in Pakistan. The significance of study is to critically evaluate the efficiency of public schools and explore the factors causing inefficiencies in public school system for policy purposes. The study has investigated the efficiency of secondary schools in District Sargodha using data envelopment analysis approach. Primary data has been collected from all secondary schools of district Sargodha in Punjab for the year 2019-20. The results showed that schools in District Sargodha showed an average technical efficiency of 79 percent and passing out rate ranged 30 percent to 95 percent. While controlling for environmental factors, urban schools were more efficient with average efficiency score of 92 percent than that of rural school with average efficiency score of 81 percent. The study figured out the important factors causing inefficiency were student background, distance travelled by the teacher coming to schools, community population, experience of head and head time allocation on administration. These factors have important implications for designing future policies of public schools sector.
Keywords: Technical Efficiency, Scale Efficiency, Tobit Regression, DEA, Secondary Education.

INTRODUCTION

Education holds paramount importance at all levels. There is a growing body of evidence, particularly at national or state levels, establishing a positive correlation between education and economic growth (Jones *et al.*, 2012). While the quantity of education is noteworthy, the quality of education, often assessed by students' performance in standard international tests holds even greater significance. Developing countries constitute about 75 percent of the total world population. But world map shows that only developed nations are ruling the world. Education provides highly equipped human resources to the society and economic development is not possible without skillful and trained human resources.

Pakistan is spending only 2.05 percent of its GDP on education whereas military expenditures are proportionally very high (World Bank, 2021). The inefficient allocation of budget creates economic, social, and political issues in Pakistan. Its Population is 19 crore and half of its population is less than 18 years. Only 2.9 percent of them gets admission in higher education institutions and about 5.5 million children are out of school (UNESCO, 2021). About 75 million children are going to school and remaining 32 percent are made to earn their livelihoods (GOP, 2020).

Secondary Education in Pakistan is a critical stage in the life of a student as it decides the future of student in Pakistan. After this stage a student gets into the higher education creating professionals for the future. Secondary education starts after the primary education and then leads to the higher secondary education. There were about 31400 institutions, 3.8 million enrolments and 0.5 million teachers (GOP, 2020). Quality of education at this stage matters and highly dependent upon several factors. There are controversies regarding the efficiency of schools. If a school is efficient in terms of resource utilization must not be efficient in terms of

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its pass out rate. The estimation of efficiency of schools in dual framework setting is somehow a difficult task.

Apart from the societal advantages, education plays a crucial role in determining the lifelong returns for individuals (Walker *et al.*, 2011). For instance, the private rate of return on investment in an additional year of schooling in a developed economy like the United States is estimated to be around 10% per year in real terms (Psacharopoulos *et al.*, 2004). This return is likely to be even higher in less developed economies. The government has to face many challenges in producing the quality education for the public. These challenges are low literacy rates, gender disparities, infrastructure and facilities, quality education, teacher training and motivation, economic barriers, technology integration and many more. The government of Pakistan has launched many reforms to improve efficiency in public sector especially in education. But these reforms have been failed due to the inefficient deliveries of the services. Detailed and proper information about efficiency of educational sector will help government and policy makers to increase the efficiency level of high schools (Ruggiero, 2004). Knowledge on efficiency would be helpful for policy makers in reducing waste in resource utilization. A significant proportion of national budget is met with the support of donor bilateral support. As two percent share of GDP is allocated to education sector, the analysis on efficiency will enable the policy maker to seek out the sources of inefficiencies. Weaknesses in the operations of schools undermine their service coverage potential even in situation where funding is not the main constraint resulting in a poor delivery system.

There are several studies who measured the efficiency of public sector schools in different context and using different technique of efficiency determination. Resources allocated for secondary education service delivery hinges on finance. Although investment in education is very low in Pakistan i.e. only 2 percent of GDP (World Bank, 2020) but there is seemingly low productivity of educational products as compared to amount of money spent on education. Absentee rate is higher in government's school teachers as compared to private school teachers (Andrabi, 2008). Private school teachers are more regular than government school teachers (Aly, 2007). This study has assessed the relationship between resources allocated and output in Pakistan's secondary education sector in district Sargodha. Pakistan's secondary education sector is not working efficiently. Because a system working efficiently yields higher output with given inputs or given output with lesser inputs. Like any other organizational decision-making unit, Secondary schools gain inputs from the environment, processes it, convert it and return back to environment as an output. To realize the importance of efficiency in the school sector, the study has analysed the factors constraining the efficient delivery of the services at the school and give a policy to remove those inefficiencies. The specific objective was to estimate the technical and allocative efficiencies of the secondary schools in district Sargodha for year 2019-2020. The study has also used the censored regression to factor out the variables causing inefficiencies in the system.

LITERATURE REVIEW

A number of studies have been reported who analysed the source of inefficiencies in different context. Saeed *et al.* (2012) conducted a survey and analysed that 85 percent teachers were present on the day of survey in government schools while 90 percent teachers were present in private schools. Although government teachers are highly qualified and experienced than private school teachers and paid better but their performance is not encouraging as compared to private school teachers (Andrabi, 2008). The resources allocated for secondary education seem to produce low productivity level meaning that inefficiency is present in the system. Public school will be efficient when an output is produced with least inputs (Olatoun, 2011). A study conducted by Saif and Anwar (2022) reviewed the relationship between child nutritional status and economic growth. If a child is taking nutritious food, it will affect the performance in studies and ultimately leads to high school results as well. The situation provides a pen picture that secondary schools in Pakistan are not operating efficiently with respect to input utilized. Since expenditures on education are largely regarded as an investment, therefore there is need to investigate and eliminate such elements creating inefficiency. A careful analysis of the public-school expenditures reveal that majority of the finance is invested on salaries and capital investment only. Therefore, it is necessary to investigate the impact of non-salary aspect of the expenditures on service quality and student's satisfaction. Palacio *et al.* (2002), Leblanc & Nguyen, 1997 and Rowley (1996) pointed out important factors that can impact a school performance. School management should keep on account that what students are expecting, and what are their perception about academic and quality teaching.

Efficiency of a productive unit is its capability to produce maximum output by given inputs (Farrell, 1957 & Boyne, 2003). There are a number of studies at national level who have used both parametric and non-parametric approaches to estimate the efficiency in different sectors. These include Maqbool *et al.* (2021), Shaheen *et al.* (2011); Abedullah *et al.* (2007), Hussain *et al.* (2012) and many others. A number of researches have been done to find the ratio of output and input. Major share of input indicates inefficiency, suggests either to maximize output or to minimize educational spending (Ruggiero, 1996) and (Grosskopf & Valdmanis, 1987). Efficiency of school is the performance of school which can be described as productivity. Production function shows the relationship between obtained output and utilized inputs. Efficiency in Education is enhanced by either

improving students' achievement or reducing the level of input" (Hughes, 2004). Efficiency can be defined for educational institution as the relationship among educational input and outcomes, especially the minimization of former and maximization of later. In the educational production, the school uses various controlled and uncontrolled inputs for producing output. In literature students' output was measured by test scores of readings, writing and mathematics test, however in some studies, number of students graduating per year, students' success in gaining admission in further programs, students earning potential in future, student's enrolment rate and pass out student's rate has been used as output. School inputs commonly used in educational studies are school size, student teacher ratio, qualification of teachers, experience of teaching staff, instructional expenditures along with non-instructional expenditures per student, non-school inputs like Socioeconomic status of student (measured by family income, number of parents, ethnic background and parental education) and other environmental factors that affect students' efficiency like geographical location i.e. rural /urban. School inputs are inputs related to the school management ownership like instructional and non-instructional activities. While non-school inputs are inputs external to the school management. In educational production many studies find insignificant relation among most of school input and output while Hanushek (1986 & 2020), Walberg and Fowler (1987), Grosskopf and Weber (1989), Deller and Rudniki (1993). Cooper and Cohn (1997) explored that environmental and socio-economic factor affects student's performance significantly. Luminesce and Lubienski (2006) suggested that autonomy, market forces, regularity freedom had generated diversity and innovation in management operations and structure of schools. A School is technically efficient if it produces its output at maximum level with given resources, inversely it can be said that if A school uses minimum resources to produce given output, it would be efficient one.

The previous studies at international level gives mixed findings of both school inputs and non-school inputs. Many studies conducted in Pakistan has used the production function approach and their results are confined to the impact of school inputs only in relation to the efficiency of school. There is more room for the research to use both school and non-school inputs in estimating the efficiency of schools using non parametric approach "Data Envelopment Analysis".

MATERIALS AND METHODS

***Data and Sampling Technique*:** There were sixteen Markaz and seven tehsils of district Sargodha. At 1st stage, out of sixteen markaz, half of them (eight Markaz) has been selected using random sampling technique in each tehsil. At second stage, in each markaz, all schools from eight Markaz out of seven tehsils has been selected for data collection. There were total 163 schools in eight markaz selected randomly in seven tehsils of District Sargodha. Primary data from 163 schools consisting of eight Markaz in seven tehsils had been collected in the year 2019-2020. For sample selection lists of all government schools in District Sargodha was collected from District Monitoring Office (DMO). The list contained the necessary information related to school name, school type (primary, middle, elementary, high, and higher secondary) school Markaz and Tehsil. As there were sixteen school's Markaz in seven tehsils of district Sargodha thus, all schools from eight Markaz out of seven tehsils has been selected for data.

***Questionnaire Design*:** A semi structured questionnaire had been designed and pre-tested in the field to get the information on different variables to use for analysis purposes. The content validity has been checked through literature review and discussion from experts in the field. Whereas the reliability has been checked through Cronbach's Alpha correlation. In pilot survey, the index comes out to be 0.69, representing the reliability of the instrument used to collect data.

The questionnaire has contained the information on demographic characteristics of the school like location of the school (Urban/Rural), type (Boys/girl) and approximate population in the school premises. The responses to questions related to the socioeconomic factors like social status and educational background of the student had also been collected. The collected information was percentage of students belongs to affluent families; percentage of students belongs to literate families, percentage of parents support for students' achievements, percentage of parents' involvement in school activities. The questions related to the admiration were also included. These were head designation, head qualification, and head experience, head time allocation on administration, instruction, teaching and public relations. Information about the number of teachers in the school at different levels, percentage of teachers coming from more than 5km distance, with an advance degree, with more than 15-year experience, attributes of teachers (Regularity, Decision making, Analytic thinking, Self-confidence, Dutiful, Tolerate, Cooperative and disciplined) were collected. The questionnaire also contained information related to the student's characteristics, amount of budget (Faroogh e Taaleem and Instructional Budget) and school characteristics. Information about school infrastructure consisted of number of classrooms (Primary, Middle, High), amount of furniture in school, number of labs, number of computers, number of books in library, number of playgrounds, number of lab assistant and number of non-teaching staff. Furthermore, availability of utilities in school (Drinking water, Drainage, Sewerage, Electricity, Gas, Phone, Internet, Trash, Garbage, Recycling, Multipurpose

Hall, Dispensary, Hostel) had also been included in the questionnaire.

***Description of the Variables*:** As school production has complex nature so it is difficult to measure school outcome. Exact and complete information about schools is not easy to collect especially the prices of inputs and output. It is difficult to know what inputs and outputs are used and what is the appropriate technique to measure them (Hanushek, 2020). It is argued in theory that the goal of education is to develop skills and knowledge in individuals to make them productive. The variables had been categorized into both input variables and output variables. Single output variable had been used for analysis. Percentage of students who got secondary school certificate examination (SSCE) was used to measure pass out rate since schools appear in same examination.

Table 1. Description of the Variables

Output Variables	Description	Past studies
Pass out rate (SSCE)	% of students who pass the Secondary School Exam.	(Hardre et al, 2006; Meunier, 2008)
Input Variables		
No of Teachers	Total no of instructors	Muvawala and Hisali (2012).
No of Students	Total no of students at all levels	Chakraborty *et al.* (2001).
Teachers with high Exp	% of teachers with more than 15 years of Experience	Chakraborty *et al.* (2001).
No of Classroom	It is used as proxy for capital (availability of basic facilities)	Muvawala and Hisali, (2012) and Ruggiero (1996)
Average class size	No of student in a class	Corney (2000)
Percentage of FTF	Amount of Faroogh e Taleem fund allocated for food	Ruggiero (2004) and Carpanter et al (2010).
Distance travelled	No of teachers coming from more than 5 kilometers.	Mancebon et al (2008).
Administration	Time allocated to administrative tasks by Principal	Carpanter et al (2010)
Student Background	% of students belong to Educated Parents	Mancebon et al (2008).
Percentage of Instructional Budget (IB)	Amount of IB allocated for school	Adkins et al (2005) and Ruggiero (2004).
Head Experience	No of years the principal was engaged in school as principal	Muvawala and Hisali (2012).
School Type	D=1 for boys, D=0 for Girls	
School Location	D=1 for urban D=0 for Rural	

It was a basis of comparison among schools related to their performance. Input variables for efficiency analysis is less problematic than output variable. The description of output and input variables had been described in Table 1.

Data Envelopment Analysis (DEA): DEA is linear programming method which use price wise nonparametric frontier for the purpose to calculate efficiencies related to this frontier. DEA is not only non-parametric technique but also a mathematical programming estimation of production function. This program consists of many models, extensively used are CRS and VRS under DEA model can be applicable for estimating scale and technical efficiencies. For the account of cost efficiency and allocative efficiency the extension of above model can be utilized by Fare *et al.* (1994). Changes in technology, technical efficiency scale and total factor productivity (TFP) can be estimated with the help of Malmquist DEA approach outlined by Fare *et al.* (1994).

The non parametric approach (DEA) requires no assumption regarding the functional form of the model. Pioneer work of Farrell was based on linear programming data envelopment analysis. Farrell purposed frontier estimation approach related to piece wise linear convex hull. Basically, Farrell extended the works of Debreu (1951). They employed basic form of firm efficiency and Pastor and Aparicio (2015) estimated efficiency using distance approach in context multi ubput and outpur scenario. Boles (1966) and Afriat (1972) used mathematical programming method. Charnes *et al.* (1978) estimated the production frontier using LP method in multi input and output setting under constant return to scale assumption. Further amendment was done by Banker (1989) in input-oriented DEA under assumption of VRS Coelli, (1998).

***DEA under constant return to scale (CRS)*:** Constant return to scale showed that a school achieves same output with each additional input Cooper and Rhodes (1978). CRS model provides proportional change in output due to input. Assume data is available on l input and k output for each of M school. The (l x p) input matrix say "x", (k x q) output matrix say "y". DEA aims to construct envelopment surface over observed data points in such a way that all points lie on or below the surface. The study has used the ratio form of the data. The study has measured ratio as output over input.

Optimal weight can be selected by

$\text{Max}_{s,t}\ (s*y_l/t*x_l)$

$\text{St } s*y_k/t*x_k \leq I,\ k=1, 2... N,$

$s, t \geq O$

S (vector of output weight)

t (vector of input weight)

Values of S and t involves such as efficiency measure of l^{th} school is maximized with constraint, all efficiency measure be less or equal to one

If constraints t*xl=1 then,

Max s, t (s*Yl)

St t*xl=1

s*Yk– t*xk<0, k=1, 2... N,
S, t > 0

This form is called as multiplier form of linear programming problem. Using duality, equivalent envelopment form can be obtained. Where S (vector of output weight), V (vector of input weight), Y (n x k matrix of outputs for all n firms) and X (n x l matrix of inputs for n firms). The efficiency score (θ) for the i^{th} firm. θ ranges between 0-1 with zero means least efficient and near to one means most efficient.

DEA under variable returns to scale: A firm could be efficient under CRS but may not be efficient under the assumption of nonexistence of perfect competition and budget constraint. Banker *et al.* (1984) provides a modified form of CRS to allow VRS when all the DMUs are not at optimal scale. VRS Model provides non proportional change in output due to inputs. Lovell *et al.* (1994) discussed that efficiency estimates were higher with BCC specification than CCR specification. It is because BCC envelopes observed data more tightly than that of CCR. The linear programming problem under CRS can be solved by modifying it to variable return to scale and adding convexity constraint as well. In figure 3.1 straight line represented CRS frontier start from origin CRS surface passes through DMU at A. Under CRS, ZLBC are inefficient DMU'S only best practice is DMU A. The VRS surface is represented by piecewise linear curve which pass through LABC. Only DMU A is scale efficient as well as technically efficient working at optimal level. Remaining school (L, B, and C) are scale inefficient but technically efficient only school Z is technically and scale inefficient. There is Possibility for school Z to reduce input up to point J to be technically efficient with same level of output. If school N is operating at point J the ratio of scale efficiency is XH/XJ.

Scale Efficiency: A firm can indeed achieve technical and allocative efficiency but still face inefficiencies related to its scale of production. When considering technology with variable returns to scale, if a firm operates at a scale that falls within the increasing returns to scale part of the production function, it should consider expanding its production to attain scale efficiency. Conversely, if a firm operates within the decreasing returns to scale part of the production process but is overly large in size, it may need to reduce its scale of operation to achieve efficiency (Coelli, 1998).

In Figs. 1 and 2, technical efficiency under CRS is the difference between the CRS surface and the observed output.

$$TE_{CRS} = PA / PS$$

Efficiency under VRS is the difference between VRS surface and observed outcome.

$$TE_{VRS} = PB / PS$$

Scale efficiency is TE under CRS minus TE under VRS

$$SE = PA / PB$$

$$TE_{CRS} = TE_{VRS} * SE.$$

In figure 2, CRS is the line at which every gives the same output for a given input whereas there may be increasing, decreasing and constant returns on VRS curve. At point 1, there exists VRS, and firm is operating below optimal production scale level. Whereas at point 3, VRS and NIRS are equal so decreasing return to scale exists which guide the firm to contract its production scale. Only at point 2 CRS, (constant return to scale) VRS (variable return to scale) and NIRS (non-increasing return to scale) are equal which is the manifestation of optimal scale.

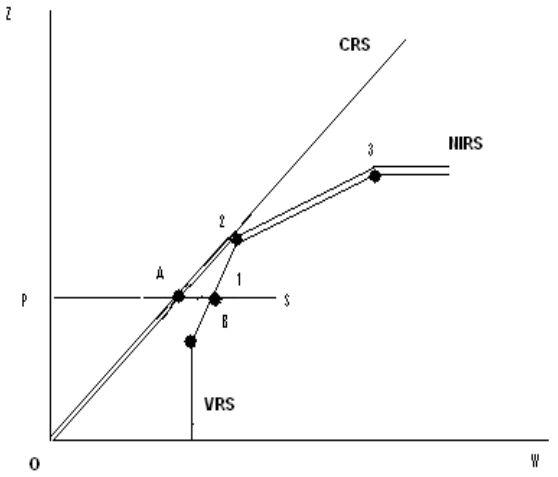

Figure 1. DEA envelopment surface under CRS and VRS

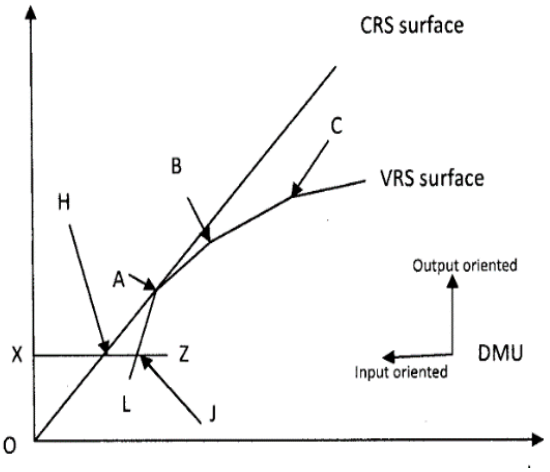

Figure 2. Scale efficiency
Source: Borge (2006). Source: Coelli, (1998)

Second Stage Analysis: Explaining the Efficiency Scores: The second step is to factor out the variables causing the efficiency differences across the firms. In contrast first stage analysis, a non-parametric surface analysis, the second stage assumes the functional form of the model. The study has employed censored regression analysis (tobit regression). Here the dependent variable (efficiency score) will range between 0 and 1 that is why the name censored as the DMUs having efficiency score less than zero and more than 1 have

been censored to value (0,1). The censored dependent variable has been influenced by a number of factors (Forsund and Sarafoglou, 2002). The OLS estimators is not a consistent estimator in this case.

RESULTS

The DEA is a many-input model and single output used in the study. The output used in the study is percentage of pass out students who appeared in secondary school certificate examination (SSCE) for the session 2019-20. Inputs variables are no of instructors in the school, total number of students in the school, average number of students in each class, total number of classrooms, percentage of FTF utilized and percentage of teachers with more than 15-year experience.

Technical and Scale Efficiency by location: The results of efficiency analysis output-oriented measures have been given in the following table. The Technical efficiency score has been calculated under both CRS and VRS according to the location of the school.

Table 2. Average technical and scale efficiencies by location.

Technical efficiency	Overall	Rural	Urban
CRSTE	0.789	0.810	0.917
VRSTE	0.852	0.864	0.932
SE	0.924	0.935	0.985

The average technical efficiency of overall schools under CRS (constant return to scale) has been reported to be 0.79. However, CRS may not be an appropriate assumption for all schools. The average efficiency score under VRS is 0.85. There were almost 15 percent technical inefficiency. Output can be expanded without increasing factors with technology. Geographical (rural/urban) TE showed that urban schools are more efficient with an average of 0.94. The average technical efficiency score of rural schools reported to be 0.92. The inefficiency due to scale operation has been the difference between TE under VRS and technical efficiency under CRS. There existed almost more than 90 percent scale efficiency for all the schools. The efficiency can be increased by altering the scale of operation. Rural schools were scale inefficient, with scale efficiency score of 0.81. This suggests that rural schools could improve efficiency by 19 percent if they change their level of operation. Urban schools had been close to efficient with T.E and S.E score 0.92 and 0.98 respectively.

***Technical Efficiency (TE) and Scale Efficiency (SE) by Tehsils and Markaz*:** Table 3 provides average efficiency scores by different Tehsils obtained assuming CRS and VRS The results showed that Sargodha tehsil has SE 0.79 as compared to other tehsils who have high level of efficiency scores. This requires 21 percent improvement in productivity by adopting more efficient scale of operations. Markaz level results in table 4.2 reported average efficiency scores at different Markaz under CRS and VRS assumption. Under CRS and VRS technical and scale efficiencies of different Markaz revealed that all Markaz had almost same level of technical efficiencies range (0.93 to 1) except Markaz Sargodha. Markaz Sargodha had technical efficiency 0.64 (required 36 percent expansion in output with same level of inputs) and scale efficiency 0.80 while 20 percent scale inefficiency existed which suggests that Markaz Sargodha could improve productivity level up to 20 percent by adopting more efficient scale of operations.

Returns to Scale: Table 4 presents the number and percentage of schools operating under various returns to scales at district level.

Table 4. Returns to scale of all schools in District Sargodha

	Total	IRS	DRS	CRS
No. of Schools	163	30	113	20
Percentage	100	18.4	69.3	12.2

The results showed that 12.2 percent schools in the overall sample have been operated on CRS while 69.3 percent schools on decreasing returns to scale. Only relatively smaller

Table 3. Average technical and scale efficiencies by Tehsils and Markaz.

Tehsil	CRSTE	VRSTE	SE	Markaz	CRSTE	VRSTE	SE
Overall	0.789	0.852	0.924	Overall	0.789	0.852	0.924
Bhalwal	0.789	0.967	0.971	Bhalwal	0.789	0.967	0.971
Kotmomin	0.947	0.955	0.992	Kotmomin	0.947	0.955	0.992
Sahiwal	0.926	0.950	0.975	Sahiwal	0.926	0.950	0.975
Sargodha	0.637	0.790	0.798	Sargodha	0.637	0.790	0.798
Shahpur	0.941	0.967	0.973	Shahpur	0.941	0.967	0.973
Sillanwali	0.954	0.960	0.993	Sillanwali	0.954	0.960	0.993
Bhera	0.978	1.000	0.978	Bhera	0.978	1.000	0.978
	-	-	-	Jhawrian	0.480	0.963	0.985

Table 5. Scale of operation by Tehsil and Markaz

Tehsil	IRS	CRS	DRS	Total	Markaz	IRS	CRS	DRS	Total
Sargodha	2	2	29	33	Sargodha	2	2	29	33
	6%	6%	88%			6%	6%	88%	
Shahpur	10	11	1	22	Shahpur	10	11	1	22
	45%	50%	5%			45%	50%	5%	
Sahiwal	12	10	6	28	Sahiwal	12	10	6	28
	43%	36%	21%			43%	36%	21%	
Bhalwal	12	6	-	18	Bhalwal	12	6	-	18
	67%	33%	-			67%	33%	-	
Silanwali	9	17	12	38	Silanwali	9	17	12	38
	24%	45%	32%			24%	45%	32%	
Kotmomin	3	6	8	17	Kotmomin	3	6	8	17
	19%	38%	40%			19%	38%	40%	
Bhera	1	7	-	8	Bhera	1	7	-	8
	13%	87%	-			13%	87%	-	
					Jahwerian	5	4	1	10
						50	40	10	

Table 6. Scale of operation by location.

Returns to scale	Urban	Rural
CRS	30.9	64.4
DRS	33.3	15.0
IRS	35.7	20.7

proportion of schools; 18.4 percent have been operated on increasing returns to scale.

The tehsil level returns to scale showed that 87 percent schools have been operated on CRS scale in Tehsils Bhera. On the other hand, in tehsil Bhalwal and tehsils Shahpur 67 percent and 45 percent schools have been on IRS (increasing retuns) respectively. Scale efficiency can be increased using more share of instructional budget and decrease average class size.

Markaz level returns to scale showed that no school in Bhera and Bhalwal markaz have been operated on decreasing return to scale. In Markaz Shahpur and Jhawrian, only 5 percent and 10 percent schools have operated under decreasing returns. Markaz with large quantity of schools and big school size operated on DRS i.e. in markaz Sargodha 88 percent schools have operated on DRS scale, the least efficient Markaz, suggested that there could be an increase in efficiency by reducing the scale of operation.

Table 6 has showed that large percentages (64.4 %) of schools have been operating on CRS, who belong to rural schools as compared to urban schools (30.9 %). While the most of the schools (with reference school size) have been on decreasing returns. These schools could be cslae efficient by reducing the operating scale. 21 percent rural schools have increasing returns could be scale efficient if they increase their scale. Further the schools belong to smaller markaz like markaz Bhera, Jhawrian, Shahpur and Bhalwal were technically and scale efficient.

Determinants of Efficiency: The first stage DEA results reported that inefficiency in schools was present. Tobit model has been used to determine the factors behind the inefficiency. The results of variables related to school specific

Table 7. Selected characteristics of technically efficient school

Variables	Definition	Hypothesis
Education	Educational background of students increases technical efficiency	+ve
Experience	Head experience increases technical efficiency	+ve
Economic condition	Students from affluent families cause inefficiency	-ve
Size of community population	Community with more population increases the technical efficiency of schools	+ve
Time utilization	Schools where head spent more time on administration are technically more efficient.	+ve
Distance	More share of teachers come from out of station schools cause inefficiency	-ve
Location	Schools located close to rural areas are technically more efficient then urban.	+ve
School type w.r.t gender	Boy's schools are technically inefficient	-ve
Instructional budget	Instructional budget increases efficiency	+ve

characteristic variables have been given in table 7. Variables were positively affecting the efficiency score of schools except affluent family background, distance, and school type with respect to gender. The Tobit regression results showed that community population has positive and significant impact in explaining technical efficiency. Generally larger localities have more population and have more opportunity to facilitate itself which increase efficiency of schools (Jones *et al.*, 2012).

Table 8. Tobit regression results.

Variables	Coefficient	t-value	p-value
Constant	0.795	10.955	0.000
Community pop	0.600	4.664	0.000
Affluent family students	-0.270	5.499	0.025
Literate family students	0.040	2.208	0.038
Head Time Allocation on administration	0.010	1.936	0.059
Head Experience	2.143	2.781	0.032
Out of station Teachers	-1.598	1.695	0.866
Location (urban=0, rural=1)	0.005	2.098	0.049
Type (Girl=0, boy=1)	-0.406	3.269	0.001
Instructional Budget	0.800	2.025	0.012

DISCUSSION

Students having affluent family background have negative and significant relationship with efficiency scores. Usually, students with wealthier background do not take interest towards their studies, either drop out, repeat the class or get very little marks resulted inefficiency level of schools. In literature there are two types of findings about students with wealthier background variable. (a). A negative relationship between prosperous community and efficiency "There is negative association between household income and average efficiency" (Denaux *et al.*, 2011). According to Jones *et al.* (2012) if unemployment rate is higher in any community that community would provide better results. Higher rate of unemployment encourages students to stay on. (b) Disadvantaged schools in poor locality have lower achievements in study by Haelermans *et al.* (2017) but our result is consistent with earlier. The variable of "Students with literate family background" affect positively and significantly to efficiency scores. The result is consistent with Ruggiero (1996). Parents education positively affect efficiency is also consistent with Jones *et al.* (2012). Locality with high unqualified adults, students from this background are more likely to drop out. Head time allocation on administration positively related to efficiency. By and large it is seen that if head of any department focus on administration, the results are better than non-administration. Head experience increase efficiency significantly. This study matches with Adkin and Moomaw, 2005 and Muvawala and Hisali, 2012. Out of station teachers have negative and insignificant relation with efficiency measure. Teachers far from schools are tired and have less opportunity to teach to students. Teachers travel from one place to another does not provide better outcomes (Haelermans *et al.*, 2017). Instructional budget variable is statistically significant in explaining efficiency. This result was also observed by Adkin and Moomaw, (2005); Denaux, (2011); Ruggiero, (1996); & Carpenter *et al.* (2010). The dummy variable of location (school operating in rural or urban areas) is positively and significantly relate to technical efficiency. This implies that rural schools are more efficient as compared to urban. This result is in line with the study that urban schools are more inefficient than that of rural because more private schools are in urban areas (Muvawala and Hisali, 2012). The dummy variable of school type with respect to gender is negatively but significantly affect to efficiency. This implies that boys' schools are less efficient as compared to girls' schools in explaining efficiency. This result is in line with the study that educational attainments in girls are higher than the boys, as boys are more drops out (Jones *et al.*, 2012).

Conclusion: The study has estimated the technical and scale efficiency of secondary schools in district Sargodha for year 2019-2020. The study has employed data envelopment analysis approach to calculate the efficiencies at tehsil, markaz and region level. The efficiency results showed that there were 21 percent technical inefficiency at constant return to scale and 15 percent technical inefficiency at variable return to scale. At VRS, the school could increase its output without increasing the input level by 15 percent. The location wise efficiency results showed that urban schools were more efficient (94%) as compared to the rural schools (92%). Markaz level efficiency results revealed that all Markaz had almost same level of technical efficiencies range (0.93 to 1) except Markaz Sargodha. Markaz Sargodha had technical efficiency 0.64 (required 36 percent expansion in output with same level of inputs). Scale efficiency of Markaz Sargodha was 0.80 while 20 percent scale inefficiency suggests that Markaz Sargodha could improve productivity level up to 20 percent by adopting more efficient scale of operations. There were 12.2 percent schools in the overall sample operated on Constant return to scale while 69.3 percent school were operated decreasing returns to sacle. Only 18.4 percent schools were on increasing returns. The returns at tehsil showed that 87 percent schools have been operating on CRS scale in Tehsils Bhera. On the other hand, in tehsil Bhalwal and tehsils Shahpur 67 percent and 45 percent have been schools were operating on increasing return to scale respectively. These tehsils could achieve optimal scale if they use more share of instructional budget and decrease average class size. Markaz level returns to scale showed that no school in Bhera and Bhalwal Markaz was operating on decreasing return to scale. In Markaz Shahpur and Jhawrian only 5 percent and 10 percent schools were operating under dimishing returns. Markaz with large quantity of schools and

big school size operate on DRS i.e. in Markaz Sargodha 88 percent schools were operated on DRS scale the least efficient Markaz. The tobit regression results showed that all the variables affected the efficiency scores positively and significantly except the variable; students with affluent background and teachers coming far (more than 5 Km). The variable teacher out of station was insignificant and has no impact on the efficiency score.

***Policy Recommendation*:** A number of options are available to deal with observed inefficient school. As the results indicated that scale of operation is prominent at tehsil level results. The tehsil Bhalwal and Shahpur showed the increasing return to scale meaning that there is need to reduce the school size in terms of total number of students. There is a need to increase the no of schools in both tehsils entailing the more demand for both school and non-school inputs contingent upon the availability of funds.

1. The planner should use scale efficiency as a tool of productivity control and determine the size where school could perform more productivity i.e., scale efficient school, and if school is greater in size i.e., exhibiting DRS should be divided into smaller schools. Similarly, the schools exhibiting IRS and are smaller in size should be expanded to work on optimal scale.
2. Whereas the closure of inefficient school is not a sufficient option due to political consideration and social structure of schools. There is need to access both the inputs and the output to analyze school efficiency and productivity instead of just devising the policy based on the output.
3. For illustration a school ranking mechanism according to efficiency level must be implemented and published in form of status table. Efficiency ranking should be from highest to lowest in defending order. This ranking of school should be done by selecting targets on the basis of available resources. This ranking of school will not only able the schools to improve themselves but also inform parents about the choice of selecting the "best school."

***Study Limitation*:** Technical efficiency results by DEA proved a significant inefficiency in the Sargodha Public School Systems. In this study, the data related to environmental factors was captured by the variable school head. The study could not get data at district level on variables not under the control of school management such as family income, parents' educational level etc due to time and cost limitation. The researchers should also focus on household variables to calculate inefficiency and determine the impact of uncontrolled inputs to estimate more accurate results for the inefficiency.

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